

APPENDIX XVI TO PART 86—POLLUTANT MASS EMISSIONS CALCULATION PROCEDURE FOR GASEOUS-FUELED VEHICLES AND FOR VEHICLES EQUIPPED WITH PERIODICALLY REGENERATING TRAP OXIDIZER SYSTEMS CERTIFYING TO THE PROVISIONS OF PART 86, SUBPART R

(a) Gaseous-Fueled Vehicle Pollutant Mass Emission Calculation Procedure.

(1) For all TLEVs, LEVs, and ULEVs, the calculation procedures specified in Chapter 5 of the California Regulatory Requirements Applicable to the National Low Emission Vehicle Program (October, 1996) shall apply. These procedures are incorporated by reference (see § 86.1).

(b) Pollutant Mass Emissions Calculation Procedure for Vehicles Equipped with Periodically Regenerating Trap Oxidizer Systems.

(1) Exhaust Emissions. (i) The provisions of § 86.1777 apply to vehicles equipped with periodically regenerating trap oxidizer systems, except that the following shall apply instead of the requirements in § 86.144–94(a):

(ii) The final reported test results shall be computed by the use of the following formula:

(iii) For light-duty vehicles and light-duty trucks:  

$$Y_{wm} = 0.43 ((Y_{ct} + Y_s) / (D_{ct} + D_s)) + 0.57 ((Y_{ht} + Y_s) / (D_{ht} + D_s)).$$

(iv) For purposes of adjusting emissions for regeneration:

$$Re = ((Yr1 \cdot Y_{ct}) + (Yr2 \cdot Y_s) + (Yr3 \cdot Y_{ht})) / (D_{ct} + D_s + D_{ht}).$$

$$Yr = Y_{wm} + Re.$$

Where:

$Y_{wm}$  = Weighted mass emissions of each pollutant, i.e., HC, CO, NO<sub>x</sub> or CO, in grams per vehicle mile.

$Y_{ct}$  = Mass emissions as calculated from the “transient” phase of the cold start test, in grams per test phase.

$Y_{ht}$  = Mass emissions as calculated from the “transient” phase of the hot start test in grams per test phase.

$Y_s$  = Mass emissions as calculated from the “stabilized” phase of the cold start test, in grams per test phase.

$D_{ct}$  = The measured driving distance from the “transient” phase of the cold start test, in miles.

$D_{ht}$  = The measured distance from the “transient” phase of the hot start test, in miles.

$D_s$  = The measured driving distance from the “stabilized” phase of the cold start test, in miles.

$Yr$  = Regeneration emission test.

$Re$  = Mass emissions of each pollutant attributable to regeneration in grams per mile.

$Yr1$  = Mass emissions, during a regeneration emission test, as calculated from the “transient” phase of the cold start test, in grams per test phase.

$Yr2$  = Mass emissions, during a regeneration emission test, as calculated from the “stabilized” phase of the cold start test, in grams per test phase.

$Yr3$  = Mass emissions, during a regeneration emission test, as calculated from the “transient” phase of the hot start test in grams per test phase.

(2) Particulate Emissions. (i) The provisions of § 86.1778 apply to vehicles equipped with periodically regenerating trap oxidizer systems, except that the following shall apply instead of the requirements § 86.145–82(a):

(ii) The final reported test results for the mass particulate ( $Mp$ ) in grams/mile shall be computed as follows.

(iii) For purposes of adjusting emissions for regeneration:

$$Mp = 0.43(Mp1 + Mp2) / (D_{ct} + D_s) + 0.57 (Mp3 + Mp2) / (D_{ht} + D_s)$$

$$Re = ((Mpr1 \cdot Mp1) + (Mpr2 \cdot Mp2) + (Mpr3 \cdot Mp3) / (D_{ct} + D_s + D_{ht}))$$

$$Mpr = Mp + Re$$

Where:

(1)  $Mp1$  = Mass of particulate determined from the “transient” phase of the cold start test, in grams per test phase. (See § 86.110–94(d)(1) for determination.)

(2)  $Mp2$  = Mass of particulate determined from the “stabilized” phase of the cold start test, in grams per test phase. (See § 86.110–94(d)(1) for determination.)

(3)  $Mp3$  = Mass of particulate determined from the “transient” phase of the hot start test, in grams per test phase. (See § 86.110–94(d)(1) for determination.)

(4)  $D_{ct}$  = The measured driving distance from the “transient” phase of the cold start test, in miles.

(5)  $D_s$  = The measured driving distance from the “stabilized” phase of the cold start test, in miles.

(6)  $D_{ht}$  = The measured driving distance from the “transient” phase of the hot start test, in miles.

(7)  $Mpr$  = Regeneration emission test

(8)  $Re$  = Mass of particulate attributable to regeneration in grams/mile.

(9)  $Mpr1$  = Mass of particulate determined, during a regeneration emission test, from the “transient” phase of the cold start test in grams per test phase. (See § 86.110–94(d)(1) for determination.)

(10)  $Mpr2$  = Mass of particulate determined, during a regeneration emission test, from “stabilized” phase of the cold start test, in grams per test phase. (See § 86.110–94(d)(1) for determination.)

(11)  $Mpr3$  = Mass of particulate determined, during a regeneration emission test, from the “transient” phase of the hot start test, in grams per test phase. (See § 86.110–94(d)(1) for determination.)

(c) Fuel Economy Calculations for Gaseous Fuels Based on the Cold Start CVS–1975 Federal Test Procedure.

(1) Assume the fuel meets HD–5 specifications (95% C<sub>3</sub>H<sub>8</sub>, 5% nC<sub>4</sub>H<sub>10</sub>, by volume).

(i) Physical constants of Propane and Normal Butane:

Component	Mol. Wt.	Sp. Gr.	Liquid density (lb/gal @ 60 °F)	Liquid density of Hd–5 (lb/gal @ 60 °F)
C <sub>3</sub> H <sub>8</sub>	44.094	0.508	4.235 ×	0.95 = 4.0233
nC <sub>4</sub> H <sub>10</sub>	58.12	0.584	4.868 ×	0.05 = 0.2434
				4.2667

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- (ii) Density of the HD-5 fuel:  
 $(0.95 \times 4.235) + (0.05 \times 4.868) = 4.267 \text{ lb/gal @ } 60^\circ\text{F}$
- (iii) Molecular Weights:  
 (A)

Species	Mol. Wt.
C .....	12.01115
H .....	1.00797
O .....	15.9994
CO .....	28.01065
CO <sub>2</sub> .....	44.00985
CH <sub>2.658</sub> * .....	14.6903

\* Average ratio of Hydrogen to carbon atoms in HD-5 fuel.

(B)

C <sub>3</sub> H <sub>8</sub> .....	8/3	=	2.666×0.95 (% propane)	=	2.533
nC <sub>4</sub> H <sub>10</sub> ...	10/4	=	2.5×0.05 (% Butane)	=	0.125
.....					2.568

- (iv) Weight of Carbon in:  
 $\text{CO} = \text{wt. of CO} \times (12.01115 / 28.01055) = \text{wt CO} \times (0.429)$

$$\text{CO}_2 = \text{wt. of CO}_2 \times (12.01115 / 44.00995) = \text{wt CO}_2 \times (0.273)$$

$$\text{CH}_{2.658} = \text{wt. of CH}_{2.658} \times (12.01115 / 14.6903) = \text{wt CH}_{2.658} \times (0.818)$$

(v) Wt. of Carbon per gallon of LPG:

$$\text{wt. of carbon} = 4.2667 \text{ lbs/gal} \times 453.59 \text{ gms/lb} \times 0.818 = 1583 \text{ grams C/gal HD-5}$$

(vi) Fuel economy:

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Where:

HC = CVS HC in grams/mile

CO = CVS CO in grams/mile

CO<sub>2</sub> = CVS CO<sub>2</sub> in grams/mile

For gasoline:

$$= 2421 / ((0.866)(\text{HC}) + (0.429)(\text{CO}) + (0.273)(\text{CO}_2))$$

For Natural Gas:

$$= 1535 / ((0.759)(\text{HC}) + (0.429)(\text{CO}) + (0.273)(\text{CO}_2))$$

[62 FR 31265, June 6, 1997]

EFFECTIVE DATE NOTE: At 62 FR 31265, June 6, 1997, appendix XVI was added, effective Aug. 5, 1997.